

What is Claimed:

1 1. A method for producing a mixture of chlorine and chlorine
2 dioxide comprising the steps of:

3 introducing an aqueous solution of an alkali metal chlorate with an
4 inorganic acid into a reactor and permitting at least 90% by volume of said alkali
5 metal chlorate to react with said inorganic acid to produce gaseous chlorine,
6 chlorine dioxide and steam in a gas head space of said reactor;

7 removing said gaseous chlorine, chlorine dioxide and steam from said
8 reactor; and

9 dissolving said gaseous chlorine, chlorine dioxide, and steam in water
10 to produce a product stream.

1 2. A method according to claim 1 including the step of mixing
2 said product stream with an aqueous moiety whereby said chlorine and chlorine
3 dioxide in said product stream react with contaminants in said aqueous moiety to
4 oxidize and/or disinfect said contaminants.

1 3. A method according to claim 1 including the step of selecting
2 hydrochloric acid as said inorganic acid.

1 4. A method according to claim 3 including the step of
2 establishing the concentration of hydrochloric acid between 5% and 40% by weight.

1 5. A method according to claim 1 including the step of
2 establishing an initial concentration of from 200 to 700 grams per liter of alkali
3 metal chlorate in said aqueous solution of alkali metal chloride.

1 6. A method according to claim 1 including the step of
2 maintaining said alkali metal chlorate solution and said inorganic acid at a
3 temperature between 20°C and 60°C in order to produce in said gaseous product
4 stream chlorine/chlorine dioxide ratios greater than 2.5.

1 7. A method according to claim 5 including the step of selecting
2 sodium chlorate as said alkali metal chlorate.

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1 8. A method according to claim 1 including the step of using a
2 horizontal reactor wherein said aqueous solution of alkali metal chlorate flows
3 through said reactor and said inorganic acid is introduced into said flow of aqueous
4 solution of alkali metal chlorate in a manner to permit said chlorine, chlorine
5 dioxide and steam to rise through said aqueous solution of alkali metal chlorate at a
6 several locations along said flow.

1 9. A method according to claim 8 including the step of
2 establishing said flow of alkali metal chlorate successively through a plurality of
3 individual horizontal reactors and adding additional inorganic acid to said flow
4 prior to each successive reactor.

1 10. A method according to claim 8 including the step of
2 withdrawing a product stream containing chlorine, chlorine dioxide and steam from
3 each of said reactors.

1 11. A method according to claim 9 including the step of allowing
2 reaction of said alkali metal chlorate and said inorganic acid to proceed
3 substantially to completion.

1 12. A method according to claim 9 including the step of flowing
2 said aqueous alkali metal chlorate through from one to twelve individual reactors
3 arranged in series.

1 13. A method according to claim 8 including the step of
2 introducing said inorganic acid into said flow of alkali metal chlorate at from three
3 to twelve separate locations spaced along a longitudinal axis of said reactor.

1 14. A method for producing a gaseous mixture of chlorine dioxide
2 and chlorine comprising the steps of:

3 establishing a volume of an aqueous solution of sodium chlorate at a
4 temperature between 20°C and 95°C;

5 introducing hydrochloric acid at several locations within said volume
6 of said aqueous solution of sodium chlorate, said hydrochloric acid having a
7 temperature between 20°C and 95°C;

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8 permitting said hydrochloric acid to react with said aqueous solution
9 of sodium chlorate causing bubbles of chlorine, chlorine dioxide and steam to rise
10 through said aqueous solution of sodium chlorate;

11 collecting gaseous chlorine dioxide, chlorine and steam in a head
12 space maintained over said volume of said aqueous solution of sodium chlorate; and

13 removing said gaseous product stream of chlorine, chloride dioxide
14 and steam from said head space.

1 15. A method according to claim 14 including the step of
2 producing a product stream by dissolving said gaseous product stream of chlorine
3 dioxide, chlorine, and steam in water.

1 16. A method according to claim 15 including the step of mixing
2 said product stream with an aqueous moiety whereby said chlorine and chlorine
3 dioxide in said product stream react with contaminants in said aqueous moiety to,
4 one of, oxidize and/or disinfect said contaminants.

1 17. A method according to claim 15 including the step of applying
2 said product stream to one of, treat potable water or waste water.

1 18. A method according to claim 15 including withdrawing said
2 product stream wherein the ratio of chlorine to chlorine dioxide is at least 1.5 to 1.

1 19. A method according to claim 1 including the step of
2 maintaining said sodium chlorate solution and said hydrochloric acid at a
3 temperature between 20 degrees C and 60 degrees C in order to produce in the
4 gaseous product stream chlorine/chlorine dioxide ratios greater than 2.5.

1 20. A method according to claim 14 including the step of
2 maintaining the partial pressure of chlorine dioxide at a level below 150 mm Hg by
3 a combination of one of or all of the steps of vacuum, dilution with chlorine, and
4 dilution with steam produced in the generation of said gaseous chlorine, chlorine
5 dioxide and steam.

1 21. A method according to claim 2 including the step of
2 maintaining the partial pressure of chlorine dioxide at a level below 76 mm Hg.

1 22. A method according to claim 14 including the step of
2 providing said hydrochloric acid at a concentration of from 5 to 40% by weight.

1 23. A method according to claim 14 including the step of
2 establishing said volume of said aqueous solution of sodium chlorate with an initial
3 concentration of sodium chlorate from 200 to 700 grams per liter.

1 24. A method according to claim 14 including the step of adding
2 chloride ion to one of said aqueous solution of sodium chlorate, said aqueous
3 solution of hydrochloric acid, or both in order to increase the ratio of chlorine to
4 chlorine dioxide in said gaseous product stream.

1 25. A method according to claim 14 including the step of obtaining
2 said chloride ion by recycling spent liquor from said method.

1 26. A method according to claim 14 including the step of using a
2 horizontal reactor wherein said aqueous solution of sodium chlorate flows through
3 said reactor and said hydrochloric acid is introduced into said flow of aqueous
4 solution of sodium chlorate in a manner to permit gaseous products of reaction to
5 rise through said aqueous solution of sodium chlorate at several of locations along
6 said flow.

1 27. A method according to claim 26 including the step of using a
2 horizontal reactor wherein said aqueous solution of sodium chlorate flows through
3 said reactor and said hydrochloric acid is introduced into said flow of aqueous
4 solution of sodium chlorate in a manner to permit gaseous products to rise through
5 the resulting aqueous solution at a plurality of locations along said flow, thereby
6 achieving a chlorine to chlorine dioxide ratio of greater than 2.5 in the product
7 stream.

1 28. A method according to claim 26 including the step of
2 establishing said flow of alkali metal chlorate successively through several
3 individual horizontal reactors and adding additional hydrochloric acid to said flow
4 prior to each successive reactor, thereby achieving a chlorine to chlorine dioxide
5 ratio more than 1.5 and less than 4.

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1 29. A method according to claim 26 including the step of
2 establishing said flow of inorganic acid successively through several individual
3 horizontal reactors and adding additional alkali metal chlorate to said flow prior to
4 each successive reactor, thereby achieving a chlorine to chlorine dioxide ratio
5 greater than 2.5.

1 30. A reactor for generating a gaseous mixture by reacting an
2 aqueous solution of an alkali metal chlorate and an inorganic acid comprising:

3 a first horizontally disposed reactor section having a first end adapted
4 to introduce said alkali metal chlorate and inorganic acid into said reactor section;

5 a second end of said reactor section having means to impound a
6 volume of said aqueous solution of an alkali metal chlorate within said reactor with
7 a gas space above said volume of said aqueous solution of an alkali metal chlorate;

8 means to introduce said inorganic acid at a plurality of locations along
9 at least a portion of the length of said volume of said aqueous solution of an alkali
10 metal chlorate;

11 means to withdraw gaseous reactant products from said gas space; and

12 collection means at said second end of said reactor section to collect
13 waste liquor from said reactor section.

1 31. A reactor according to claim 30 wherein said means to
2 introduce said inorganic acid is a diffuser disposed along the length of said volume
3 of said aqueous solution of said alkali metal chlorate.

1 32. A reactor according to claim 30 wherein said reactor includes
2 means to heat said aqueous solution of alkali metal chlorate and said inorganic acid
3 before introduction into said reactor section.

1 33. A reactor according to claim 30 including means to maintain
2 said reactor section at a constant temperature.

1 34. A reactor according to claim 30 wherein said reactor includes
2 means to heat said aqueous solution of alkali metal chlorate and said inorganic acid
3 as it flows from storage into said reactor section.

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1 35. A reactor according to claim 30 wherein substantially all
2 components of the reactor are designed to contain pressure of at least 180 psig.

1 36. A reactor according to claim 30 including means to use
2 pressurized water to drive an ejector to create a vacuum to draw a mixture of
3 chlorine dioxide, chlorine and steam into said water whereby said steam is
4 condensed by said water and said chlorine dioxide and said chlorine are dissolved in
5 said water.

1 37. A reactor according to claim 36 including an auxiliary tank
2 connected to said reactor and said tank such that said water containing said
3 dissolved chlorine dioxide and said chlorine are conducted to a tank wherein air
4 separated from gaseous chlorine dioxide and chlorine can be safely vented and a
5 solution of chlorine dioxide and chlorine dissolved in water can be withdrawn from
6 said tank as a product stream.